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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/863,291 | 05/24/2001 | Kazunori Anazawa | 109593 | 9227 |

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| EXAMINER |
|---|
| LISH, PETER J |

| ART UNIT | PAPER NUMBER |
|---|---|
| 1754 | 6 |

DATE MAILED: 06/06/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 09/863,291 | ANAZAWA ET AL. | |
| | Examin r | Art Unit | |
| | Peter J Lish | 1754 | |

*-- Th MAILING DATE of this communication appears on th cover sh t with the correspond nc addr ss --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *25 March 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

Applicant's arguments with respect to claims 1-7 have been considered but are moot in view of the new ground(s) of rejection.

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-5, 7-8, 10-12, and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. (USPN 5,876,684) taken with Chiharu et al. (JP 11116218).

Withers et al. disclose a method for the production of fullerenes and nanotubes in a suitable heat generating system, such as a plasma zone created by an electric arc between two electrodes (See Figures 13a and 13b). In this method, a fluid form that may be carbon particulates or a form of hydrocarbon in a liquid or gaseous state are continuously fed to the reaction zone and supplied with heat from the source in an atmosphere and under other conditions that cause formation of fullerenes (column 2, lines 1-13). Because hydrogen can interfere with the fullerenes ring closure, hydrocarbons with low hydrogen/carbon ratios such as benzene, naphthalene, etc. are preferred (column 9, lines 60-67). Withers et al. also teach the process of evacuating the system to $10^{-3}$ torr before pressurizing the system and creating the arc (Example 1). Withers et al. do not however teach the formation of single-walled nanotubes, nor do they teach the use of a catalyst within the carbon feed.

Chiharu et al. teach the use of catalysts for the production of single-walled carbon nanotubes using various processes known for producing fullerenes. Chiharu et al. teach that single-walled carbon nanotubes can be produced by the plasma method, wherein a carbon component is introduced into a plasma frame and the carbon materials exiting the plasma are cooled (paragraph [0018]). A single-walled nanotube can be made effectively by constituting all or part of the carbon component from methane and introducing the carbon component with metal nanoparticle catalysts, such as those comprising iron, cobalt, or nickel. It would have been obvious to one of ordinary skill at the time of invention to add the catalyst materials of Chiharu et al. to the carbon feed of Withers et al. in order to produce single-walled nanotubes.

Withers et al. teach the use of a pressure within the range of $10^{-6}$ to 760 torr. The selection of a specific pressure range, such as that between 39.9 kPa (300 torr) and 79.8 kPa (600 torr), is determined to be the optimization of a known process, which could have been determined through routine experimentation, and is held to be obvious by *In re Boesch* 205 USPQ 215.

Regarding the apparatus claims (4-7 and 12-13), Withers et al. disclose an apparatus comprising electrodes for arc discharge, a carbon liquid supply unit and a carrier gas supply unit (See figures 13a and 13b). They teach that the carrier gas may be introduced in the chamber comprising the reactor through a passageway that may be provided in an electrode, through the carbon supply feed tube, or generally into the container (column 4, lines 50-54). Withers et al. also teach the advantages of cooling the region surrounding the reaction zone by the use of water cooled coils surrounding the electrodes, in order to enhance quenching of the vaporized carbon and the collection of fullerenes (column 5, lines 8-13). Withers et al. teach a heater, specifically

the arc discharge apparatus, which heats and vaporizes the carbonaceous feed. Withers et al. do not teach at least one electrode of the pair of electrodes comprising catalytic particles.

Chiharu et al. teach the use of catalysts for the production of single-walled carbon nanotubes using various processes known for producing fullerenes. For an arc discharge process, Chiharu et al. teach that single-walled nanotubes may be produced by constituting a part of a carbon electrode, especially the positive electrode, with metal catalyst particles, such as those comprising iron, cobalt, or nickel (paragraph [0016]). It would have been obvious to one of ordinary skill at the time of invention to supply catalyst particles in an electrode in the process of Withers et al. in order to produce single-walled nanotubes.

Regarding claim 5, Whereas Withers et al. do not specifically teach an apparatus capable of spraying a mist of carbon liquid into the reaction zone, they do teach that when employing a solid carbon source, particulates of a very small size (micron diameters) be used in order to achieve a quick and complete vaporization. Thus, it would be obvious to one of ordinary skill at the time of invention to use a fine mist of liquid carbon feed in order to achieve a quick and complete vaporization.

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. and Chiharu et al. as applied to claim 4 above, and further in view of Smalley et al. (USPN 5,227,038).

Withers et al. do not provide for a gap adjustment mechanism in his apparatus, however they do teach that the electrode may be vaporized and used as a raw material for the production of fullerenes or rather that pyrolyzed carbon can deposit on the electrodes, in both cases altering the electrical operation of the arc (column 10, lines 53-55). Smalley et al. teach that it is

necessary to provide some means for maintaining a consistent arc gap between the two electrodes. He teaches the use of a spring connected to one or both of the electrodes to urge one toward the other with a relatively constant force (column 4, lines 34-46). It would be obvious to one of ordinary skill at the time of invention to include the gap adjustment mechanism of Smalley et al. in the apparatus of Withers et al. in order to prevent the altering of the electrical operation of the arc due to carbon deposition on the electrodes.

Claims 9 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. and Chiharu et al. as applied to claims 1 and 4 above, and further in view of Journet et al. ("Large-scale production of single-walled carbon...").

Neither Withers et al. nor Chiharu et al. disclose the use of yttrium catalysts for the growth of single-walled carbon nanotubes in an electric arc process. Journet, however, teaches that a mixture of yttrium and nickel catalyst particles gives the highest yield of single-walled nanotubes in an electric arc process and that yttrium strongly favors the growth of single-walled nanotubes. It would have been obvious to one of ordinary skill at the time of invention to include the nickel and yttrium catalyst particles, taught by Journet et al., in the process of Withers taken with Chiharu in order to increase the yield of single-walled carbon nanotubes.

***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter J Lish whose telephone number is 703-308-1772. The examiner can normally be reached on 9:00-6:00 Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on 703-308-3837. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-305-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

PL
May 29, 2003

STUART L. HENDRICKSON
PRIMARY EXAMINER